4.10 HUMAN HEALTH AND ENVIRONMENT

This section discusses the potential human health and environment effects of the proposed project. The methodology for determining effects is presented, followed by a description of the effects for each alternative. Potential impacts on human hearing are addressed in Section 4.9, Noise Impacts.

Methodology

The electric and magnetic field (EMF) effects of the transmission lines were calculated for a range of distances from the transmission line. In general, the farther removed a person is from the transmission line, the lower the EMF strength. A number of different scenarios were tested in the calculations. Because the magnetic field varies with the current carried on the transmission line, magnetic field strength was calculated for both the normal anticipated current load of 250 million volt-amperes (MVA) per circuit, and the maximum anticipated current load of 500 MVA per circuit. Calculations were also performed for a number of different transmission line configurations (vertical optimized phasing orientation or vertical non-optimized phasing orientation) that can affect the EMF strength. In the optimized phasing orientation, the phases of the two circuits are offset to minimize the EMF strength. As described in Section 3.10, the focus of EMF health studies and the focus of the following impacts analysis is on magnetic fields, although electric fields are included for completeness.

Since Tucson Electric Power Company's (TEP) policy is to minimize EMF exposure levels to the extent practicable, TEP would use the vertical optimized phasing orientation for the double-circuit line. Results from the non-optimized phasing orientation are included for comparison purposes only. The calculations evaluate EMF strength at a range of distances from the centerline of the transmission line, both within and outside the approximate 125-ft (38-m) right-of-way (ROW). The magnetic field is expressed in units of milligauss (mG); the electric field is expressed in units of kilovolt per meter (kV/m).

The potential for corona effects and effects on safety is also evaluated. The nearest potential receptors to the transmission line based on the proposed corridors are listed for each alternative, including residences, schools, and commercial establishments.

4.10.1 Electric and Magnetic Fields

4.10.1.1 *Western Corridor*

Electric and Magnetic Field Effects. The Western Corridor would consist primarily of single steel pole double-circuit structures strung with 345-kV conductors. The spacing of the structures would be in the range of 600 to 1,000 ft (183 to 305 m) apart. The minimum ground clearance of the conductors would be 32 ft (9.8 m).

Table 4.10–1 lists the EMF strength under normal anticipated load conditions for the 345-kV double-circuit transmission line. Table 4.10–2 lists this same information for maximum anticipated load conditions. EMF strength is given for both the optimized phasing configuration that would be used by TEP, and for the non-optimized phasing configuration for comparison purposes. Figures 4.10–1 and 4.10–2 graphically illustrate the EMF strengths, respectively, for the optimized phasing configuration of the transmission line (Meyer 2001a). The distances given represent the distance of a receptor from the centerline of the transmission line. At a given distance, the electric and magnetic field strength would be nearly identical on both sides of the transmission line.

Table 4.10–1. EMF Strength for Normal Operating Conditions (250 MVA Current, 345-kV Double Circuit).

Distance from Centerline (feet)	Optimized Phase Configuration		Non-optimized Phase Configuration (for comparison purposes only)	
	Magnetic Field Strength (mG)	Electric Field[a] Strength (kV/m)	Magnetic Field Strength (mG)	Electric Field[a] Strength (kV/m)
1500	0.002	0.001	0.102	0.004
1250	0.004	0.001	0.146	0.006
1000	0.007	0.002	0.228	0.009
750	0.017	0.003	0.405	0.015
500	0.056	0.007	0.904	0.034
450	0.076	0.009	1.112	0.041
400	0.108	0.012	1.401	0.051
350	0.159	0.016	1.817	0.065
300	0.248	0.021	2.448	0.084
250	0.418	0.030	3.467	0.113
200	0.777	0.042	5.257	0.153
175	1.114	0.048	6.698	0.175
150	1.667	0.050	8.785	0.192
125	2.627	0.032	11.934	0.183
100	4.403	0.054	16.897	0.084
90	5.520	0.129	19.667	0.054
80	6.999	0.252	23.055	0.214
70[a]	8.973	0.448	27.198	0.497
60	11.612	0.753	32.223	0.946
50	15.108	1.203	38.171	1.630
45	17.228	1.486	41.440	2.078
40	19.598	1.799	44.821	2.601
35	22.190	2.122	48.196	3.186
30	24.936	2.418	51.400	3.812
25	27.713	2.638	54.233	4.438
20	30.351	2.729	56.508	5.014
15	32.653	2.659	58.117	5.492
10	34.433	2.450	59.081	5.838
5	35.552	2.206	59.544	6.042
0	35.934	2.093	59.673	6.108

[a] Beyond edge of 125 ft ROW.
Source: Meyer 2001a.

Table 4.10–2. EMF Strength for Maximum Operating Conditions (500 MVA Current, 345-kV Double Circuit).

Distance from Centerline (feet)	Optimized Phase Configuration		Non-optimized Phase Configuration (for comparison purposes only)	
	Magnetic Field Strength (mG)	Electric Field [a] Strength (kV/m)	Magnetic Field Strength (mG)	Electric Field[a] Strength (kV/m)
1500	0.004	0.001	0.203	0.004
1250	0.007	0.001	0.293	0.006
1000	0.014	0.002	0.457	0.009
750	0.034	0.003	0.810	0.015
500	0.112	0.007	1.807	0.034
450	0.153	0.009	2.224	0.041
400	0.216	0.012	2.801	0.051
350	0.318	0.016	3.364	0.065
300	0.497	0.021	4.897	0.084
250	0.835	0.030	6.934	0.113
200	1.553	0.042	10.514	0.153
175	2.227	0.048	13.396	0.175
150	3.334	0.050	17.570	0.192
125	5.254	0.032	23.868	0.183
100	8.807	0.054	33.795	0.084
90	11.040	0.129	39.334	0.054
80	13.998	0.252	46.109	0.214
70[b]	17.945	0.448	54.395	0.497
60	23.223	0.753	64.446	0.946
50	30.217	1.203	76.343	1.630
45	34.455	1.486	82.881	2.078
40	39.196	1.799	89.643	2.601
35	44.381	2.122	96.393	3.186
30	49.871	2.418	102.800	3.812
25	55.425	2.638	108.466	4.438
20	60.702	2.729	113.017	5.014
15	65.306	2.659	116.234	5.492
10	68.866	2.450	118.163	5.838
5	71.105	2.206	119.088	6.042
0	71.867	2.093	119.346	6.108

[a] Electric field strength is not affected by the current load. Thus, electric field strength values given for normal and maximum operating conditions are the same.
[b] Beyond edge of 125 ft ROW.
Source: Meyer 2001a.

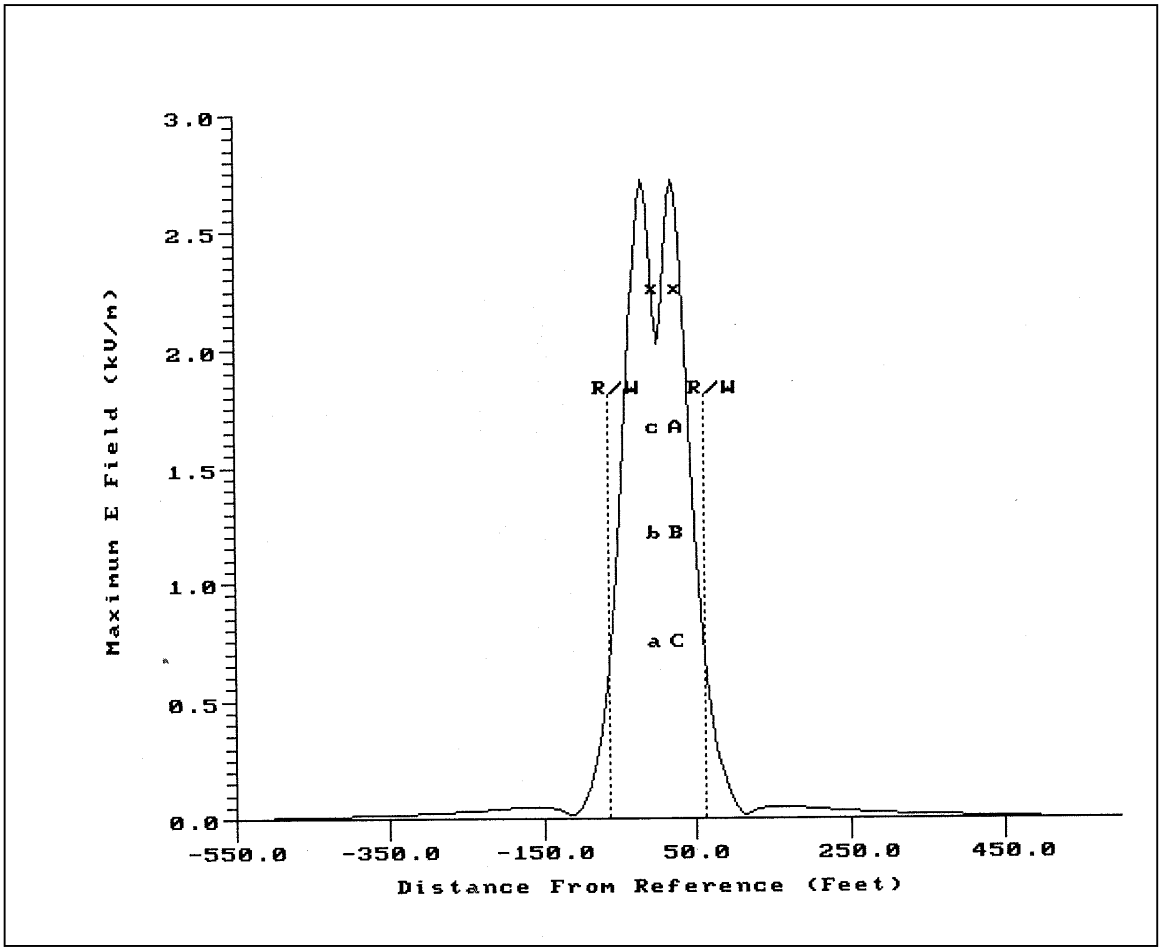

Figure 4.10–1. Electric Field Strength for Normal Operating Conditions, Optimized Phasing.

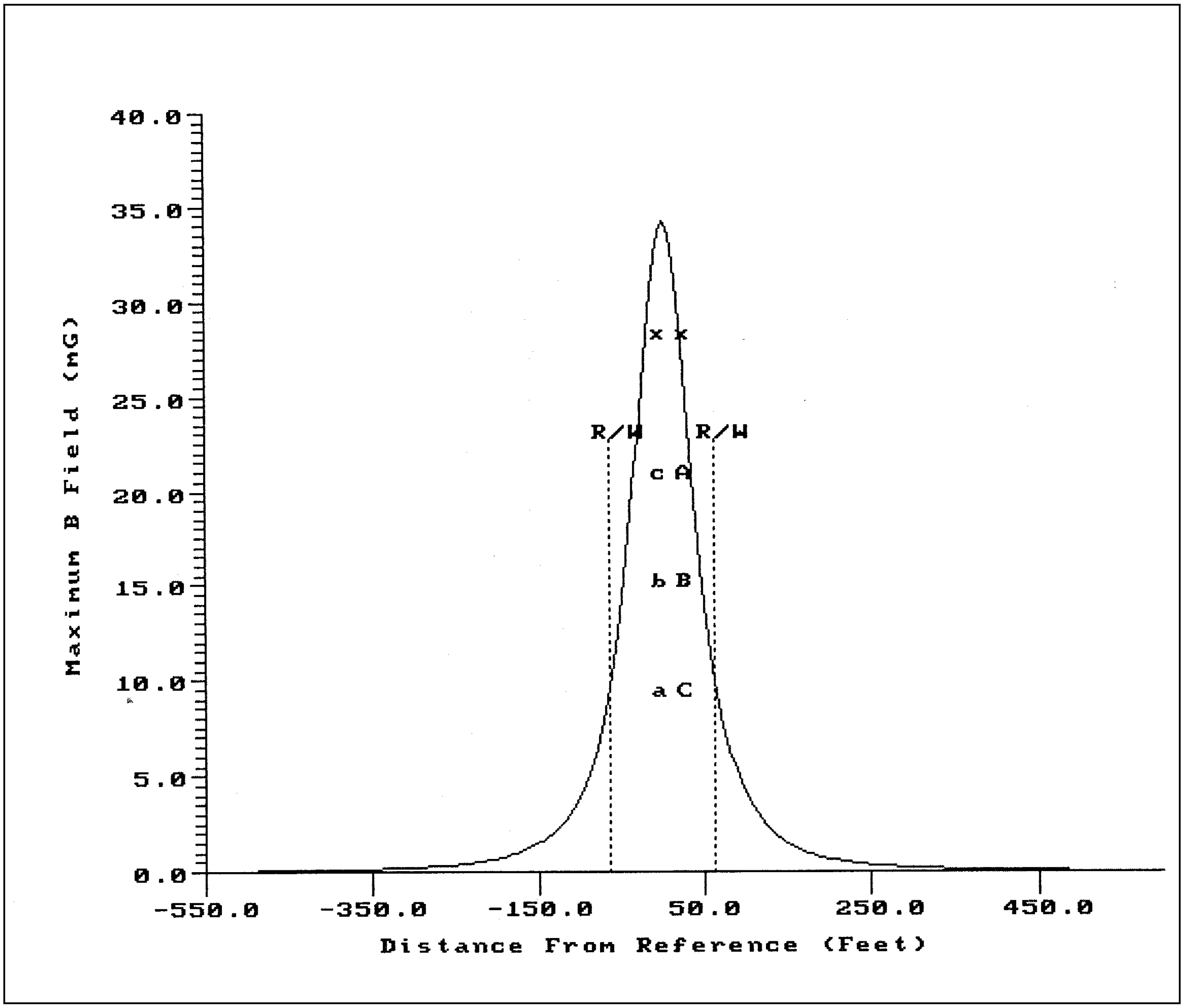

Figure 4.10–2. Magnetic Field Strength for Normal Operating Conditions, Optimized Phasing.

Beyond the edge of a 125-ft (38-m) ROW, the magnetic field strength of the optimized phasing configuration under normal operating conditions would be 8.9 mG. This would diminish to 4.4 mG at a distance of 100 ft (30 m) from the centerline, 0.78 mG at a distance of 200 ft (61 m) from the centerline, and 0.25 mG at a distance of 300 ft (91 m) from the centerline. For comparison purposes only, the non-optimized phasing configuration would result in a magnetic field of 27 mG at the edge of a 125-ft (38-m) ROW, three times the magnetic field from the optimized phasing configuration. Temporary exposure to magnetic fields on this level of magnitude are similar to being 1 ft (0.3 m) away from common household appliances such as a mixer or hair dryer (Waveguide 2003).

The electric field strength at the edge of a 125-ft (38-m) ROW under normal operating conditions for the optimized phasing configuration would be 0.45 kV/m. This would diminish to 0.054 kV/m at a distance of 100 ft (30 m) from the centerline, 0.042 kV/m at a distance of 200 ft (61 m) from the centerline, and 0.021 kV/m at a distance of 300 ft (91 m) from the centerline.

Tables 4.10–1 and 4.10–2 demonstrate the EMF strength reductions that would be achieved by TEP’s use of the optimized phasing configuration, compared to the non-optimized phasing configuration. Two shield wires, which provide necessary shielding for lightning protection, would be placed near the top of each pole to shield the 12 345-kV phase subconductors. Each circuit of a double-circuit transmission line consists of three phases; each phase consists of two subconductors. Phasing between the two circuits would be configured in a way that would minimize EMF strength.

Magnetic field levels would be elevated in the vicinity of the proposed ROW on Bureau of Land Management (BLM) land and in other areas where TEP’s proposed project would be adjacent to existing transmission lines, west of Sahuarita and Green Valley as shown in Figure 3.11–1. As an example of maximum combined EMF from existing transmission lines and the proposed project, TEP has modeled EMF levels from the proposed project on BLM land, where the proposed project runs adjacent to the south of 345-kV and 138-kV transmission lines. At the southern edge of the ROW of TEP’s proposed transmission line (340 ft [104 m] south of the existing 345-kV transmission line), the magnetic field would be 12.1 mG and the electric field would be 0.83 kV/m. At a distance of 200 ft (61 m) south of the proposed centerline, the magnetic field would be 0.9 mG and the electric field would be 0.045 kV/m. This would diminish to a magnetic field of 0.44 mG and an electric field of 0.024 kV/m at a distance of 300 ft (91 m) from the centerline (TEP 2003).

It is the policy of TEP that no residences would be within the ROW. The nearest residences to the proposed Western Corridor ROW are a group of about five houses at a distance of approximately 1,000 ft (305 m) from the ROW centerline, south of Sahuarita Road, west of the Town of Sahuarita. Sahuarita High School and Middle School are approximately 4,000 ft (1,200 m) south of the ROW centerline.

In the segment from Gateway Substation to the U.S.-Mexico border, there are warehouses and apartments approximately 1,000 ft (305 m), from the corridor centerline. Mary Welty Elementary School is located more than 1 mi (1.6 km) to the east of the ROW near the U.S.-Mexico border.

Long-term EMF exposure at these nearest residences, schools, and commercial establishments would be well below 0.8 mG, an average daily exposure to maximum magnetic fields from some common household appliances (NIEHS 1999). The EMF strengths conform to those normally found in comparable lines.

Safety. As described in Section 3.10.1, the electric field created by a high-voltage transmission line extends from the energized conductors to other conducting objects such as the ground, towers, vegetation, buildings, vehicles, and persons. Potential field effects can include induced currents, steady-state current shocks, spark discharge shocks, and in some cases field perception and neurobehavioral responses. The following describes the potential for effects on safety, and design mitigation measures that would be incorporated.

Induced Currents. The 345-kV transmission lines would have a minimum ground clearance of 32 ft (9.8 m) to reduce the potential for induced current shocks. In addition, permanent structures in the ROW, such as fences, gates, and metal buildings would be grounded.

Steady-State Current Shocks. Features reducing the level of potential for induced current in objects near the transmission line also reduce the level of a possible induced current shock. The proposed lines would be constructed in accordance with industry and TEP standards to minimize hazardous shocks from direct or indirect human contact with an overhead, energized line. These lines are not expected to pose any such hazards to humans.

Spark Discharge Shocks. In accordance with TEP's transmission line standards, the magnitude of the electric field would be low enough that spark discharge shocks would occur rarely, if at all. The potential for nuisance shocks would be minimized through standard grounding procedures. Carrying or handling conducting objects, such as irrigation pipe, under transmission lines can result in spark discharges that are a nuisance. The primary hazard with irrigation pipes or any other long objects, however, is electrical flashover from the conductors if the section of pipe is inadvertently tipped up near the conductors. The transmission lines would be constructed with adequate ground clearance to minimize these effects.

Field Perception and Neurobehavioral Responses. Perception of the field associated with the transmission lines would not be felt beyond the edge of the ROW. Persons working under the ROW might feel the field. Studies of short-term exposure to electric fields have shown that fields may be perceived (for example, felt as movement of arm hair) by some people at levels of about 2 to 10 kV/m, but studies of controlled, short-term exposures to even higher levels in laboratory studies have shown no adverse effects on normal physiology, mood, or ability to perform tasks (DOE 2001a). The International Commission on Non-Ionizing Radiation Protection Guidelines recommend that short-term exposures be limited to 4.2 kV/m for the general public. The exposures associated with the proposed action are below this recommended limit, reaching a maximum of less than 2.8 kV/m within the ROW (ICNIRP 2003).

The single pole steel structures that would be used are non-climbable. The ground clearance of the conductors would be a minimum of 32 ft (9.8 m), adequate clearance for safety considerations as related to most recreational activities.

The Amended Certificate of Environmental Compatibility issued to TEP on October 29, 2001, by the ACC (ACC 2001) includes a provision that all transmission structures must be at least 100 ft (30 m) away from the edge of the existing 50 ft (15 m) El Paso Natural Gas Company (EPNG) pipeline ROW. TEP would comply with this provision.

Smoke is a conductor of electrical current. When a fire is in the vicinity of a 345-kV transmission line, firefighters would monitor smoke near the transmission line for possible fire starts outside fire perimeter. Firefighters would remain at a distance that would not leave them vulnerable to the electric current or shock.

Power Line Hazards are identified in the Forest Service Fireline Handbook (NWCG Handbook 3, PMS 410-1, NFES 0065). If possible, the power company should deactivate lines in the fire area that may endanger firefighters. All personnel should be cautioned against directing water streams or aerial retardant into high-tension lines. They should also be made aware that the smoke may become charged and conduct the electrical current. Deactivated transmission and distribution lines may continue to pose a hazard due to induction. TEP and any involved firefighting personnel would follow the mitigation and safety requirements on pages 53 and 54 of the Fireline Handbook, and additional mitigation and safety requirements in Forest Service Handbook (FSH) 6709.11 (Health and Safety Code Handbook) on pages 30-29 and 30-30.

4.10.1.2 *Central Corridor*

The Central Corridor would involve the construction of 345-kV double-circuit transmission lines. The EMF strengths calculated for the Western Corridor would also apply for the Central Corridor. However, the list of nearest receptors to the transmission lines would be different for the Central Corridor.

Table 4.10–1 lists the EMF strength under normal anticipated load conditions for the 345-kV double-circuit transmission lines. Table 4.10–2 lists this same information for maximum anticipated load conditions. Figures 4.10–1 and 4.10–2 graphically illustrate the electric and magnetic field strengths, respectively, for the optimized phasing configuration of the transmission lines. The distances given represent the distance of a receptor from the centerline of the transmission lines. At a given distance, the EMF strength would be nearly identical on both sides of the transmission line ROW.

The nearest receptors to the proposed Central Corridor ROW include all of those listed for the Western Corridor, with the following additions. In the Tubac area there are multiple residences between 1,200 and 1,800 ft (370 to 550 m) from the centerline of the ROW. The nearest residences to the Central Corridor are three houses approximately 500 ft (150 m) from the centerline, north of Aliso Springs Road in Tubac. The Sopori School is located approximately 1 mi (1.6 km) east of the ROW in the town of Amado. The Cascabel School is approximately 2.2 miles (3.5 km) to the east of the ROW.

Long-term EMF exposure at these nearest residences, schools, and commercial establishments would be well below 0.8 mG, an average daily exposure to maximum magnetic fields from some common household appliances (NIEHS 1999). The EMF strengths conform to those normally found in comparable lines.

The potential for effects on safety and design mitigation measures for the Central Corridor are the same as those listed for the Western Corridor.

4.10.1.3 *Crossover Corridor*

The Crossover Corridor would involve the construction of 345-kV double circuit transmission lines. The EMF strengths calculated for the Western Corridor would also apply for the Crossover Corridor. The nearest potential receptors and the maximum long-term EMF exposure from the transmission lines would be the same as for the Western Corridor.

The potential for effects on safety and design mitigation measures for the Crossover Corridor are the same as those listed for the Western Corridor.

4.10.1.4 *No Action Alternative*

Under the No Action Alternative, TEP would not build the proposed transmission line and associated facilities as proposed in this EIS. There would be no EMF exposure associated with the project. EMF exposure from existing transmission lines and household appliances would be expected to continue according to current trends.

4.10.2 Corona Effects

4.10.2.1 *Western Corridor*

Corona is the electrical breakdown of air into charged particles caused by the electrical field at the surface of conductors. As described in Section 3.10.2, corona is of concern for potential radio and television interference, audible noise, and photochemical reactions.

Audible Noise. Noise levels generated by the transmission lines would be greatest during damp or rainy weather. For the proposed lines, low-corona design established through industry research and experience would minimize the potential for corona-related audible noise. The proposed lines would not add substantially to existing background noise levels in the area. Research by the Electric Power Research Institute (EPRI) (EPRI 1982) has validated this by showing the fair-weather audible noise from modern transmission lines to be generally indistinguishable from background noise at the edge of a 100 ft (30 m) ROW. During rainy or damp weather, an increase in corona-generated audible noise would be balanced by an increase in weather-generated noise. For a complete assessment of the noise from the Proposed Action and alternatives, refer to the analysis of noise in Section 4.9.

Radio and Television Interference. Transmission line-related radio-frequency interference is one of the indirect effects of line operation produced by the physical interactions of transmission line electric fields. The level of such interference usually depends on the magnitude of the electric fields involved. The line would be constructed according to industry standards, which minimize the potential for surface irregularities (such as nicks and scrapes on the conductor surface), sharp edges on suspension hardware and other irregularities around the conductor surface that would increase corona effects. However, if such corona interference were to be generated, no interference-related complaints would be expected given the distance of residents from the transmission lines. Federal Communications Commission regulations require each project owner to ensure mitigation of any such interference to the satisfaction of the affected individual.

Visible Light. The corona levels associated with the proposed transmission lines would be similar to those of existing transmission lines. The visible corona on the conductors would be observable only under the darkest conditions with the aid of binoculars. There would be no effects on the operation of observatories in the project vicinity (Fred Lawrence Whipple and Kitt Peak Observatories) from the proposed project (Criswell 2002).

Photochemical Reactions. The maximum incremental ozone levels at ground level produced by corona activity on the proposed transmission lines would be similar to that produced by the existing lines in the area. During damp or rainy weather the ozone produced would be less than 1 ppb. This level is insignificant when compared to natural levels and their fluctuations (DOE 2001a).

Corona would be mitigated by using proper line design and by incorporating line hardware shielding. The design of electrical hardware and equipment considers the potential for corona effects.

4.10.2.2 *Central Corridor*

The corona effects generated under the Central Corridor would be the same as those described for the Western Corridor.

4.10.2.3 *Crossover Corridor*

The corona effects generated under the Crossover Corridor would be the same as those described for the Western Corridor.

4.10.2.4 *No Action Alternative*

Under the No Action Alternative, TEP would not build the proposed transmission line and associated facilities as proposed in this EIS. There would be no corona effects associated with the project.